REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have incorporated the subject matter of claims 41 and 44 respectively into claims 1 and 2; and, correspondingly, have cancelled claims 41 and 44 without prejudice or disclaimer. Moreover, in light of cancelling of claims 41 and 44, Applicants have amended dependencies of claims 42 and 45.

Initially, withdrawal of finality of the Office Action mailed October 5, 2006, is respectfully requested. As the Examiner has set forth no basis in the "DETAILED ACTION" for rejection of claims 41-46, it is respectfully submitted that the application is not in a condition for the Office Action to be a Final rejection.

In any event, it is respectfully requested that the present amendments be entered, notwithstanding Finality of the Office Action mailed October 5, 2006. Noting that the present amendments incorporate subject matter of dependent claims into independent claims, it is respectfully submitted that the present amendments clearly do not raise any new issues, including any issue of new matter; and, moreover, materially limit issues remaining in connection with the above-identified application. Noting further arguments and clarifications in the Office Action mailed October 5, 2006, it is respectfully submitted that the present amendments are timely.

In view of the foregoing, it is respectfully submitted that Applicants have made the necessary showing under 37 CFR 1.116(b)(3); and that, accordingly, entry of the present amendments is clearly proper.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the prior

art applied by the Examiner in rejecting claims in the Office Action mailed October 5, 2006, that is, the teachings of the U.S. patent documents to Gotoh, et al., No. US 2002/0066465, to Skee, No. US 2002/0077259, to Kim, et al., No. US 2004/0038839, to Matsuo, et al., No. 6,296,714 and to Luo, et al., No. 6,524,168, under the provisions of 35 USC 103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a cleaning solution, or such process for cleaning semiconductor substrates using such cleaning solution, as in the present claims, the solution having components as recited in the present claims, including an oxidizing agent and an acid, and wherein a ratio of an amount by weight of the acid to an amount by weight of the oxidizing agent is in a range of 1.0-100 (note claims 1 and 2); more specifically, wherein such ratio is in a range of 1-60 (see claims 42 and 45).

In addition, it is respectfully submitted that the applied references would have neither disclosed nor would have suggested such a cleaning solution, having features as discussed previously in connection with claims 1 and 2, and, moreover, wherein the solution also includes a corrosion inhibitor. See claim 2.

Furthermore, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such cleaning solution as in the present claims, having features as discussed previously in connection with claims 1 and 2, and also having other features of the present invention as in the remaining claims being considered on the merits in the present application, including (but not limited to) the further definition of materials of the oxidizing agent, and/or acid, and/or fluorine compound, as in claims 4-11 and 22-31; and/or amount of fluorine compound as in claims 43 and 46; and/or further definition

of the basic compound added to adjust the pH range, as set forth in claims 12, 13, 32 and 33; and/or wherein the corrosion inhibitor is polyethyleneimine (see claim 14); and/or wherein the solution further includes a surfactant (see claims 15 and 34), in particular the further definition of the surfactant as in claims 16, 17, 35 and 36; and/or wherein the solution is adapted for cleaning semiconductor substrates having metal wiring which includes copper alone or a laminate structure of copper and a barrier metal (see claims 18 and 38).

Furthermore, even assuming, arguendo, that the applied prior art would have established a prima facie case of obviousness, the evidence of record in Applicants' specification (note especially the Examples and Comparative Example 2, discussed infra) shows unexpectedly better results achieved by the present invention, and establishes unobviousness of the presently claimed subject matter.

The present invention relates to a cleaning solution for removing substances attached to the surface of semiconductor substrates, and a process for cleaning using such solution. Such solution can remove substances strongly attached to the surface of semiconductor substrates without damaging metal wiring and interlayer insulation films on the semiconductor substrate.

In present-day semiconductor processing, lithography is used as a process for producing wirings and patterned insulation films on a substrate such as a silicon wafer. In such lithography, a patterned resist is used as a mask, and a desired pattern is formed on a layer below the patterned resist; thereafter, the patterned resist is completely removed.

In forming the desired pattern in the layer below the resist layer, e.g., by dry etching, residues derived from the dry etching gas, the resist, the film being patterned and other materials in the chamber of the dry etching apparatus, are

formed, and must be removed utilizing, e.g., a cleaning solution. Various previously utilized cleaning solutions are described on page 2, lines 18-23, page 3, lines 6-11, and in the paragraph bridging pages 3 and 4, of Applicants' specification. However, these previously proposed cleaning solutions have various problems, as described in the paragraph bridging pages 2 and 3, and the paragraph bridging pages 3 and 4, of Applicants' specification. These problems include that prior cleaning solutions do not sufficiently clean the substrate from the residues, and/or do not clean at a sufficient rate, can cause corrosion of wiring, and/or can have a harmful effect on the environment. These problems have become especially acute recently, where copper is used for the wiring and wiring has become finer.

Against this background, Applicants provide a cleaning solution, and method of use thereof, which can be used to completely remove etching residues without damaging the wiring materials (for example, without corrosion thereof), which is safe, and which exhibits reduced adverse effect on the environment. Applicants have found that by utilizing a cleaning solution which includes an oxidizing agent, an acid and a fluorine compound, and which has a pH adjusted in a range of 3-10 by addition of a basic compound, the concentration of water in the solution being 80% by weight or greater, and wherein a ratio of an amount by weight of the acid to an amount by weight of the oxidizing agent is in a range of 1.0-100, objectives according to the present invention are achieved; and, in particular, a cleaning solution for semiconductor substrates is achieved which can completely remove etching residues without adverse effect (e.g., without corrosion) on, e.g., wiring on the semiconductor substrate, and which is safe and has little adverse effect on the environment.

In particular, by adjusting concentrations (amounts) of the oxidizing agent, the acid and water as in the present claims, etching residues can be efficiently removed, and corrosion of wiring materials can be effectively suppressed. See, for example, page 7, lines 12-14, of Applicants' specification.

Furthermore, by utilizing a concentration (amount) of fluorine compound as in, e.g., claims 43 and 46, etching residues can be efficiently removed, while corrosion of wiring materials can be avoided.

In addition, with pH of the cleaning solution in the range recited in the present claims, etching residues can be efficiently removed. Note, for example, page 11, lines 22-25, of Applicants' specification.

As to advantageous results achieved according to the present invention, attention is respectfully directed to the Examples and Comparative Examples on pages 13-23 of Applicants' specification. Note, in particular, Comparative Example 2 in Table 3 on page 17, as compared with Examples within the scope of the present invention. It is respectfully submitted that the composition of Comparative Example 2 corresponds to disclosure in the applied reference of Gotoh, et al., in having a ratio of acid to oxidizing agent of 0.02, as discussed further infra. As can be seen in Table 3 on page 17 of Applicants' specification, the removal of etching residues in Comparative Example 2 was only "fair". As to what is meant by this description of removal, see from page 13, line 25 to page 14, line 4, of Applicants' specification. It is respectfully submitted that the evidence in Applicants' specification shows unexpectedly better results achieved according to the presently claimed subject matter, including ratio of amount by weight of the acid to amount by weight of the oxidizing agent, clearly supporting unobviousness of the presently claimed subject matter. In this regard, it is respectfully submitted that this evidence

in Applicants' specification must be considered in determining patentability of the presently claimed subject matter. See In re DeBlauwe, 222 USPQ 191 (CAFC 1984).

In the paragraph bridging pages 9 and 10 of the Office Action mailed October 5, 2006, the Examiner contends that the data in the specification is not sufficient to overcome the prima facie case of obviousness, the Examiner contending that the data is not commensurate in scope with the claimed invention and that the instant claims recite broad categories such as "oxidizing agent" and "an acid" with no proportions. Applicants respectfully submit that the claims clearly recite a proportion or ratio of amount by weight of the acid to amount by weight of the oxidizing agent, which constitutes an important feature of the present invention, especially important to the invention as claimed in the above-identified application. It is again noted that Comparative Example 2 in the specification of the above-identified application utilizes a ratio of acid (chelating agent) to oxidizing agent corresponding to the disclosure of Gotoh, et al., discussed infra. Moreover, as Gotoh, et al. has been applied as the primary reference, it is respectfully submitted that Gotoh, et al. constitutes the closest prior art. Contrary to the allegation by the Examiner, it is respectfully submitted that the evidence of record establishes unexpectedly better results achieved according to the present invention, as compared with the closest prior art, for the subject matter of all of the present claims, and particularly in connection with the present claims reciting specific oxidizing agents and/or acids, noting especially claims 4-10.

Gotoh, et al. discloses a cleaning method for removing deposits on a surface of a material to be treated, without damaging the material to be treated, the composition including an oxidizing agent, a chelating agent and a fluorine

compound, which composition flows on a surface to be treated at a high speed to thereby clean the surface to remove residues on the surface. See paragraph [0010] on page 2 of Gotoh, et al. Note also paragraphs [0017] and [0018] on page 2 of Gotoh, et al., respectively further defining the oxidizing agent and chelating agent; and paragraph [0020] on page 2, defining amount of chelating agent included in the cleaning agent. Note also paragraph [0021] on page 3 of Gotoh, et al., further defining the fluorine compound and amount thereof. Gotoh, et al. also discloses that the pH of the cleaning solution shall not specifically be restricted, and is usually used in a range of pH 3-12; and that when the cleaning solution is used in an alkaline condition, ammonia, amine and quaternary ammonium hydroxides may be added, and when it is used in an acidic condition organic acids and inorganic acids may be added. See paragraph [0026] on page 3 of Gotoh, et al.

As seen in the foregoing, as well as from a full review of this reference, it is respectfully submitted that this reference does not disclose, nor would have suggested, such cleaning solution as in the present claims, or method of use thereof, including requirement of an acid, or the ratio of amount by weight of the acid to that of the oxidizing agent.

It is acknowledged that there is overlap between the chelating agents in Gotoh, et al. and the acids in the present invention. However, in view of the large number of chelating agents described in Gotoh, et al., it is respectfully submitted that the teachings of this reference would have neither disclosed nor would have suggested the requirement of including both the acid and oxidizing agent, much less in the specified ratio, and advantages achieved thereby.

In connection with this ratio, the Examiner contends in the paragraph bridging pages 4 and 5 of the Office Action mailed October 5, 2006, that the teachings of

Gotoh, et al. "would suggest a ratio of acid to oxidant" (emphasis added) as in claims 3 and 21. Initially, it is noted that claims 3 and 21 have previously been cancelled without prejudice or disclaimer, and present claims 1 and 2 recite a more specific range for this ratio than that set forth previously in claims 3 and 21.

In any event, it is respectfully submitted that, as shown in the following, the teachings of Gotoh, et al. would not have disclosed or suggested a ratio of acid to oxidant as in the present claims. Thus, it is noted that the Examiner has pointed to no evidence or reasoning as a basis for the assertion that the teachings of Gotoh, et al. would "suggest" the recited ratio of acid to oxidant. Without evidence or reasoning in support thereof, the basis for the rejection is improper. See In re McKellin, 188 USPQ 428 (CCPA 1976).

In addition, it is noted that Gotoh, et al., at paragraph [0017] on page 2 thereof, discloses that the oxidizing agent used has a content of 0.0001-60% by weight based on the cleaning agent, and also at paragraph [0020] describes that the chelating agent has a content of 0.01-10% by weight based on the cleaning agent. However, Gotoh, et al. does not disclose a ratio of chelating agent to oxidizing agent. In this connection, for example, calculation of the ratio of chelating agent to oxidizing agent according to Tables 1 and 2 in Gotoh, et al. provides ratios of 0.03 and 0.04, outside the scope of claims 1 and 2. It is respectfully submitted that Gotoh, et al. would have neither taught nor would have suggested the presently claimed subject matter, including ratio of amount of acid to amount of oxidizing agent, and advantages thereof.

It is respectfully submitted that the secondary references as applied by the Examiner would not have rectified the deficiencies of Gotoh, et al., such that the

presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Skee discloses compositions useful in the microelectronics industry for cleaning semiconductor wafer substrates, the compositions containing one or more metal ion-free bases dissolved in water in sufficient amount to produce a pH of about 10 or greater, and a bath stabilizing effective amount, generally about 0.1% to about 50% by weight, of at least one bath stabilizing agent including at least one compound with at least one pKa in a range of 10-13. Note especially paragraphs [0026]-[0030] on pages 2 and 3 of Skee. See also paragraph [0031] on page 3 of Skee, describing that the compositions may contain other components such as silicates, chelating agents, organic solvents and surfactants. See also paragraphs [0042] and [0043] on pages 4 and 5 of Skee, describing various chelating agents. Note also paragraphs [0044] and [0045] on page 5 of Skee.

Even assuming, arguendo, that the teachings of Skee were properly combinable with the teachings of Gotoh, et al., such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, including, inter alia, requirement of including an acid, or ratio of amount by weight of acid to that of oxidizing agent, as in the present claims, and advantages thereof.

With respect to the subject matter of claims 5 and 23, attention is respectfully directed to the teachings of Kim, et al. and Matsuo, et al.

Kim, et al. discloses an organic stripping composition and an etching method using the same, the organic stripping composition including a compound containing a hydroxyl ion, a compound including fluorine ion and a sufficient amount of an oxidizing agent to control the pH of the composition to within the range of from about

6.5 to about 8.0. Note paragraph [0023] on page 2 of Kim, et al. Note also paragraphs [0025], [0026] and [0040] on pages 2 and 3 of Kim, et al.

Initially, it is noted that Kim, et al. is directed to an organic stripping composition. It is respectfully submitted that one of ordinary skill in the art concerned with in Gotoh, et al. would not have looked to the organic stripping composition of Kim, et al.

In any event, even assuming, arguendo, that the teachings of Gotoh, et al. and Kim, et al. were properly combinable, such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, including, inter alia, the requirement of the acid, and the above-described ratio, and advantages achieved thereby.

Matsuo, et al. discloses a washing solution for washing the surface of a semiconductor substrate such as a silicon wafer, the washing solution containing 0.0001-0.1% by weight of an organic acid and 0.005-0.25% by weight of hydrofluoric acid and having a pH of 2-4. See column 2, lines 39-43. As for the organic acid, note column 2, lines 44-50.

Even assuming, arguendo, that the teachings of Matsuo, et al. were properly combinable with the teachings of Gotoh, et al., such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, including the requirement of including the acid, or the above-described ratio of amount of acid to amount of oxidizing agent, and advantages thereof.

Insofar as applied in connection with claim 14, Luo, et al. discloses compositions that are useful as polishing compositions for chemical-mechanical polishing of semiconductors, the compositions being aqueous and including an oxidizing agent such as an alkali metal chlorate or hydrogen peroxide, an inhibitor of

a polyalkyleneimine, and a pH buffer such as ammonium phosphate or an alkali metal carbonate, and, optionally, a complexing agent, oxide suppressants and other inhibitors. See column 1, lines 52-62. Note also column 2, lines 30-34.

Initially, it is noted that Luo, et al. is directed to a composition for chemical-mechanical polishing. It is respectfully submitted that one of ordinary skill in the art concerned with in Gotoh, et al., directed to a cleaning technique, would not have looked to the chemical-mechanical polishing composition of Luo, et al.

In any event, even assuming, arguendo, that the teachings of these applied references were properly combinable, such combined teachings would have neither taught nor would have suggested the presently claimed cleaning solution, including, inter alia, the requirement of including the acid, or the discussed ratio of amount of acid to amount of oxidizing agent, and advantages achieved by the present invention having such features.

Applicants respectfully direct the Examiner's attention to the withdrawn claims, that is, claims 19, 20, 39 and 40, directed to a method of use of the cleaning solution. Upon allowance of claims directed to the solution, it is respectfully requested that the Examiner reconsider and rejoin the method claims, since where the claims directed to the cleaning solution are allowable the use of such cleaning solution as in the present process claims must also be allowable.

In view of the foregoing comments and amendments, withdrawal of the Finality of the Office Action mailed October 5, 2006, entry of the present amendments, and allowance of all claims presently in the above-identified application, both those directed to the cleaning solution and those directed to the process of use thereof, are respectfully requested. At least, entry of the present

amendments, and reconsideration and allowance of the claims being considered on the merits in the above-identified application, are respectfully requested.

Applicants request any shortage in fees due in connection with the filing of this paper be charged to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (case 396.43501X00), and credit any excess payment of fees to such Deposit Account.

Respectfully submitted,

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